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The Province of Alberta

PETROLEUM AND NATURAL GAS CONSERVATION BOARD

IN THE MATTER OF THE GAS RESOURCES PRESERVATION ACT

AND IN THE MATTER OF the application of Westcoast Transmission Company Limited and Westcoast Transmission Company Ltd. (Alberta Incorporation) for a permit authorizing the purchase and sale of Natural Gas in the Province of Alberta for transmission to points in the Province of British Columbia and the States of Washington and Oregon in the United States of America.

I. N. McKinnon Esq., Chairman

D. P. Goodall Esq.

Dr. G. W. Govier

Session: April 11th, 1950.

Volume 18.

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I N D E X

VOLUME 18.

April 11th, 1950.

WITNESSES

EXHIBITS

VOLUME 18.

April 11, 1950.

THE CHAIRMAN: Mr. McDonald, there was certain information that you were to supply the Board with and one was a brief submission listing items taken into consideration in establishing the percentage marketable.

MR. McDONALD: I think, Mr. Chairman, if you would just refer to the file which is left on your desk there. This is a compilation of sundry exhibits filed during the hearing together with statements in respect to further information requested. This morning I intended to call Dr. Nauss to deal with the items in order and I hope I have not forgotten too many of them.

I may say, sir, that I would ask the leave of the Board to call Dr. Nauss this morning to deal with these exhibits. That is, matters he had dealt with on the previous hearing and also submissions of additional data on reserves with respect to wells that have been brought in since he last gave his evidence before the Board.

Then in the morning Mr. Poor will be available to deal with costs and rates if anyone has any further questions. Then I would make the suggestion that Mr. Brownie of the Gas Company deal with the matter of market and then Dr. Hetherington will proceed and deal with the overall provincial picture, as requested by the Board. I think that will take us until Thursday and then I may have something to say as to an adjournment at that time. I would then ask that Dr. Nauss be called.

MR. C. H. B. FRERE: Before you proceed I would like to say I am here representing the Consolidated Mining & Smelting Company of Canada Limited. This company is interested in the

VOLUME 13.

April 12, 1950.

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MR. C. L. B. FRENCH: Before you proceed I would like to say I am here representing the Consolidated Mining & Smelting Company of Canada Limited. This company is interested in the

proceedings before this Board from two standpoints. The first is as a consumer of large quantities of natural gas at its nitrogen plant at Turner Siding near Calgary, and seondly, as a prospective customer for large quantities of natural gas at its chemical and metallurgical plants at Kimberley and Trail, British Columbia. At some later stage in the proceedings, I should like to ask if it is in the plans or in the application that a pipe line should be built to Trail, because we may be able to use natural gas at both Trail and Kimberley as substitutes for fuel oil or coal.

THE CHAIRMAN: Do you intend to call any witnesses on behalf of Consolidated or make any statement at all?

MR. FRERE: We may, at some later stage, make a statement as to the use of natural gas at the nitrogen plant near Calgary. We thought we might make a statement with reference to the use of gas at our nitrogen plant. There has been some evidence given, I believe, in this hearing as to the plant continuing in operation and probably we might add something to that evidence.

THE CHAIRMAN: Are there any other parties wish to register before we start again? Then call Dr. Nauss.

ARTHUR W. NAUSS, Recalled.

Q BY MR. McDONALD: Dr. Nauss, in the bound volume I have left with all parties - I might explain that the binding contains copies of the exhibits that I filed during the course of the proceedings in loose leaf form. I have placed in this binding practically all of the loose leaf exhibits so that they will be handy for reference for anyone who wants to refer to them. The contents contains a statement of the information requested in letter form and then the exhibits in the envelope also marked by letters "A" to "G", those are new items which have

not been placed before the Board previously.

Dr. Nauss, you are still under oath in these proceedings?

A Yes, sir.

Q Would you refer to the letter of Imperial Oil Limited re gas plant deliveries from the Leduc field, which is marked "A". I could file, sir, that letter as an exhibit, if the Board pleases?

DOCUMENT IN QUESTION NOW MARKED EXHIBIT 78.

MR. SMITH: Is this one of the letters already in?

MR. McDONALD: No, it is not in. It is one of the documents which I have lettered in this submission, which have not been filed as exhibits.

THE CHAIRMAN: That is Exhibit 78, a letter from the Imperial Oil Limited?

MR. McDONALD: From Imperial Oil Limited to D. P. McDonald, dated February 16, 1950.

Q Dr. Nauss, at page 101 of the transcript you were asked by the Chairman to obtain information from Imperial Oil Limited with respect to the statements you made as to the capacity of the Leduc plant which is in the course of construction by Imperial Oil?

A Yes, sir.

Q Would you read this letter in reply to your inquiry to them?

DR. NAUSS:

"

February 16, 1950.

Mr. D. P. McDonald,
Fisher, McDonald & Fisher,
201 Lancaster Building,
CALGARY, Alberta.

Dear Sir:

We have your letter of February 13th requesting

"a statement from this Company on the capacity of the Leduc Gas Conservation Plant, with particular reference to the evidence given by Dr. Nauss in the current hearings before the Conservation Board.

Information pertinent to the plant now under construction is as follows:

1. Process facilities, utilities and services are designed for a maximum throughput of 24,000 MCF per stream day.
2. Based on estimated gas volumes available from Leduc-Woodbend field in the next year or so, compressor capacity for only 19,000 MCF per day at the estimated delivery pressures from the low and high pressure gathering systems, is being installed. In other words, the plant capacity will initially be limited by compressor capacity to approximately 19,000 MCF per day, but can ultimately be expanded to 24,000 MCF per day by installation of additional compressors.
3. The total annual field gas production will be governed by:
   (a) Type of primary reservoir drive--our present thinking is that there will be a bottom water influx in the D-3 reservoir and the gas/oil interface should not move appreciably.
   (b) The outlet or market for crude oil.

   Considering these factors, it is our general opinion that the ultimate plant capacity of 24,000 MCF per day should not be exceeded for about five years.
4. Plant capacity does not contemplate handling gas from the Golden Spike field, nor would the present gathering system be adequate for this purpose. At

" this time there are insufficient data available from the Golden Spike pool to indicate what is the desirable primary reservoir drive. The crude in the D-3 reservoir is under-saturated; no aquafer has been encountered in three wells drilled. It has yet to be determined whether water or gas injection will be desirable and until considerably more subsurface information is obtained, we cannot formulate any plans.

5. We are not considering expanding the Leduc Plant to 40,000 MCF per day in view of present indications that the existing plant will be adequate for five years. In any event, expansion to this volume would probably require a new plant.

You will appreciate that large capital expenditures are involved in this project and a prime consideration is to minimize these while still providing economic capacity for the anticipated field volumes.

While the foregoing is at some variance with Dr. Nauss' evidence, we believe it only fair to him to refer back to evidence submitted by Mr. W. D. C. Mackenzie on behalf of this company, before the Dinning Commission. At that time the figure of 40-48,000 MCF per day was generally quoted as the potential gas production for the Leduc-Woodbend field, and consideration was given to this potential in various designs for the gathering system. It was emphasized, however, during the Dinning Commission that the plant design was predicated on 24,000 MCF per day, although we were not in a position to state the type of reservoir drive and whether

"gas or water injection would be desirable. On the basis of subsequent reservoir data, we are now of the opinion that water influx from the D-3 aquafer will occur. If so, the gas volumes produced along with the crude oil will not reach the magnitude that might have been expected from an expanding gas cap drive in the D-3 and our estimates have been modified accordingly.

We believe it is worthwhile to restate the view expressed before the Dinning Commission that estimates by reservoir engineers early in the life of any major oil field are subject to continual revision. While the engineering work done to date on the Leduc reservoirs has been most comprehensive, the fact remains that the field is still in the early stages from the standpoint of reservoir life. Much more is to be learned and our ideas on reservoir drive mechanisms may or may not change materially in the future.

Yours very truly,

"W. O. Twaits"

W. O. Twaits,
Management Assistant. "

WOT:jv

Q Hawe you any comment to make on that letter with regard to your previous statement, Mr. Nauss?

A At the bottom of the first page you will notice, of that letter, you will notice that they stated: "It is our general opinion that the ultimate plant capacity of 24,000,000 cubic feet per day should not be exceeded for about five years." That intimates that possibly later there would be reason for an increase. In other words, this letter refers to the first five years. Our figures as set up have been less than 24,000,000 per day for the first five years.

Q Have you anything to say with regard to the increase after five years in the gas that will be available for the plant?

A As Imperial points out, it is a little difficult to predict what might happen. But assuming that the production at Leduc rose to 50,000 barrels per day and that the gas/oil ratio rose to 800 cubic feet per barrel, then you would have 40 million cubic feet per day.

Q Would you turn, Dr. Nauss, to the item marked "B" in this compilation,"preliminary data sheet", furnished by Canadian Gulf Oil Company. That reference, Doctor, I think, is to Volume 5 at page 222. You made reference to the acreage which you have used in your calculation is by reason of the information furnished you by Canadian Gulf Company. You then undertook to file a letter received from the Canadian Gulf. This is the letter, dated November 18th, 1949, addressed to Mr. Frank McMahon and signed by Rush Greenslade. That will be Exhibit 79.

DOCUMENT IN QUESTION NOW
MARKED EXHIBIT 79.

Q To this letter is attached a tabulation, Preliminary Data Sheet?

A Yes.

Q Would you refer there to the point that we were discussing at page222 of the transcript, that is the acreage. I think it is Item 3 under "B".

A Item B is "Basic Reservoir Data" and Item 3 is "Estimated Area of the Pool", and then they have here 17,250 acres. I would like to point out that this sheet is the basis for the reserve estimate that I included in Table "A" of Exhibit 3.

Q And then another reference. The next item you have in this is a graph of the back pressure tests of the Pincher Creek field. That was requested. I submit that as Exhibit 80.

GRAPH IN QUESTION NOW
MARKED EXHIBIT 80.

Q Have you any comment with regard to this Exhibit 80, Dr. Nauss? This is supplied to you by what company?

A This was supplied by the Canadian Gulf Company.

Q And would you look at Exhibit 80 and explain briefly what it is?

A This Exhibit 80 is a graph showing the results of the back pressure tests on Pincher Creek wells. On this graph the square of the formation pressure minus the square of the sand face pressure is plotted against the flow rate, the measured flow rate. The curve marked Number 1 is the flow test on Pincher Creek No. 1 well conducted in March 1948. The open hole section was from 11,755 to 11,927 and the section was not acidized and when these five individual tests are plotted on this graph it indicates an open flow capacity of 45 million cubic feet per day. Curve Number 2 is a similar test on the Pincher Creek No. 1 well, conducted in September 1948. Tests through perforations in 5-inch casing, and this section was not acidized and the open flow potential indicated by that period was 16,700,000 cubic feet per day.

(Go to page 1299)

A No. 3 is the result of a test on the Marr Well conducted in June 1949. The interval open at the bottom of hole was from 12,255 to 12,768. The section was not acidized. The open flow potential indicated is 14 million cubic feet per day.

Now, the 4th curve is a test on the Walter Marr well conducted in August 1949 and the open section was 12,255 feet to 12,480 feet, and that interval was acidized with 3,000 gallons prior to the test. They had some difficulty with the tests and were only able to obtain one reliable point, which is plotted as a circle at the lower left hand end of the graph.

In Graphs 1 and 2 and 3 there are two slopes, so they had the choice of using the slope of curves 2 and 3, or the slope of curve No. 1. The Gulf engineerstook the more conservative slope and plotted up that curve using a slope the same as the curve No. 2, which gave an open flow capacity for the well, an absolute open flow capacity for the well of 83 million cubic feet per day. If they had been more liberal, optimistic, they might have taken curve No. 1, the slope of curve No. 1, and projecting the measured flow using that slope would have put the top of that curve much farther to the right and would have given an open flow capacity on the order of 150 million cubic feet per day.

Q And the next item is the graph marked "D" in this compilation, back pressurecurves of the Jumping Pound Field. This, I believe, was referred to in Volume 7, page 399, of the record. I would submit, Sir, that as Exhibit 81.

BACK PRESSURE CURVES OF THE JUMPING POUND FIELD PUT IN AND MARKED EXHIBIT 81.

Q Would you comment on the back pressure curves of the Jumping Pound wells as shown by the Exhibit?

This is a copy of a graph obtained from the Shell Oil Company and is a back pressure graph. It shows that the open flow capacity, absolute open flow capacity of Well 4-24-J at Jumping Pound is 32 million cubic feet per day, and the slope of that curve is 1.25. Well 5-7-1, the curve for that is the lower curve and the absolute open flow indicated is 38 million for that well. The slope is 1.08. By averaging those two curves you get an average open flow of 35 million cubic feet per day with an average slope of 1.15.

I forgot to mention in regard to the Pincher Creek graph that in our deliverability calculations the more conservative slope on this Pincher Creek graph was the basis for the deliverability calculations we presented here before.

Q Now, sir, pursuant to our undertaking, we have revised a Table "A", Exhibit No. 3, and that is found, sir, in the envelope attached to this. It is marked "A". I presume, sir, that should be marked?

REVISED TABLE "A" PUT IN AND MARKED EXHIBIT 82.

Q Now, possibly, Dr. Nauss, before dealing with that Exhibit 82, that is the Revised Table "A", that you refer to the comment you have which is marked "E" in this compilation, sources of data included in Table "A" of Exhibit 3. That, sir, is contained in the booklet and the reference there is to Volume 6 at page 314. It might be in order, Sir, to mark that as an exhibit.

SOURCES OF DATA INCLUDED
IN TABLE "A" OF EXHIBIT 3
PUT IN AND MARKED
EXHIBIT 83.

Q Would you now deal with Exhibit 82 and also Exhibit 83.

A Exhibit 82 is Revised Table "A" and the changes made on that were mainly to include new discoveries that were made, or new developments that were made during the last Hearing. The first item is Legal. The new reserve, the new marketable reserve, is 58 billion on that table. The revised figure is the result of the drilling of Imperial Waybrook No. 1 Well, which has several successful drillstem tests in the Viking. We reported on that in the last Hearing. At Castor a correction should be made for the Castor Field. One of those sands was the Viking and the other was the Lower Cretaceous. We had them on the original table as both Lower Cretaceous. And another addition, Ranfurly, is added. Ranfurly No. 1 is a well north of the northwest end of the Viking-Kinsella Field. Those are the three additions and changes.

Q THE CHAIRMAN: Dr. Nauss, in regard to Table 2 of Exhibit 3, have you made any amendments to that Table to correspond with the amendments you have made in this Exhibit No. 82?

A Of gas in place?

Q Yes?

A No, I have not.

MR. McDONALD: He can do that.

Q THE CHAIRMAN: I think there should be corresponding amendments made in Table 2, possibly at a later date. Also, when those amendments are being made to Table 2, you should show the gas in place for each formation or zone so

that you can follow the gas in place with this statement here.

A Yes, sir, we can do that.

Q MR. McDONALD: Yes, sir. Now, if you would deal with Exhibit 83.

A The following table gives the sources of data included in Table "A" of Exhibit III. All of the columns have not been included in this table because they were either derived from the columns covered by Table "B" or were calculated by some systematic method as follows.

The figures in the column headed "Acre Feet" were obtained by multiplying the proved acreage by the thickness. The Reservoir Temperature was obtained in general by making use of the geothermo gradient. The formula used is as follows: F = M plus (0.015d) where "F" is the formation temperature, "M" is the mean annual temperature, and "d" is the depth of the formation.

The Deviation Factor was determined experimentally in only one case, i.e., the Pincher Creek Field. In all of those cases where analyses were available for the gas, the deviation factor was calculated by calculating pseudo reduced temperatures and pressures, and from these the deviation factor was obtained. Where analyses were not obtainable, the deviation factor was read from charts published in handbooks which are based on the specific gravity of the gas.

The amount of Reserves per Acre Foot is calculated from the preceding columns.

Proved Reserves to 100 lbs. are calculated from the preceding columns except in those cases

where the reserves were calculated by the pressure decline method, in which cases the reserves were copied directly from Dr. Hume's report. Also in the case of oil fields, the reserves of solution gas are obtained by calculating the amount of oil in place, multiplying by the gas/oil ratio and deducting the unrecoverable gas.

The Percentage Marketable is an estimate based on the physical conditions of the pool.

The last column is obtained by applying this percentage to the column marked "Proved Reserves to 100 lbs.".

I will refer to Table "D" and go through an example. We will take the Legal area as an example. Under proved acreage I have the No. 3, and at the end of the Table you will notice I have some footnotes and under the No. 3, opposite the No. 3, I have "Area Delineated by Wells". That indicates that there was no geological, no seismic information available and the area is based entirely on the number of wells in the pool. Under "Thickness" I have the number 7, and the footnote, you will notice, opposite 7, "Measured from Electric log and drill stem tests." Referring again to the body of Table "B" and that Legal area, under the column "Porosity" you will note the figure 15, and referring to the end of the Table, "15 - Porosity estimated by comparison with sands having measured porosity." Connate water --

Q Just a moment. That porosity estimated by comparison with sands having measured porosity, is there any relation of where the sands were with relation to that area? I mean, what sands were the measured sands?

A I don't understand your question.

Q What I meant was, was the sand you compared, was that in the Legal area, in that immediate area or what area?

A Well, they are not in that immediate area, no. They are all porosity determinations that we have in our files. In other words, by visual examination of the sand you can make a very good estimate of the porosity. In fact, by careful study under a microscope you can come within 1 or 2 per cent.

Q In dealing with 17, connate water.

A 17, "Connate water estimated from the nature of sand." The nature of the sand there again is used in cases where we do not have measured connate water. We have to estimate it realizing that as the permeability goes up the connate water goes down and varies within certain limits. Reservoir pressure, I have the figure in No. 23 there, and in that case that was from the files of the Imperial Oil Limited. In like manner, you can obtain the source of data for all of the different items, these primary items on Table III.

Q Then you have dealt with factors at recovery percentages as part of this submission?

A The recovery percentages in Table "A". The percentages as shown in the second last column are taken on the column marked "Proved Reserves to 100 lbs." This column already shows a deduction of from 2.5 to 44 per cent of the gas in place. For the gas left in the reservoir due to an abandonment pressure of 100 lbs., the higher the pressure the lower the percentage left at 100 lbs. This 2.5 per cent, I believe, is the Pincher Creek field, which has the highest pressure of the group, and the 44 per cent is for the lowest pressure.

Dr. A. W. Nauss - Dir. Ex.

Percentages in the second last column include the following: (a) An additional amount to take care of a higher abandonment pressure than 100 lbs. In general, 100 lbs. is quite low for abandonment pressure. Pincher Creek and Jumping Pound, I am quite sure, will have higher abandonment pressures and a number of the other pools will also have a higher abandonment pressure, so under present marketable we have a certain proportion to allow for a higher abandonment pressure than 100 lbs.

(Go to page 1306)

Q Yes?

A In the dry gas pools this will amount to zero in the lower pressure pools, and would be as high as possibly 5% in the deeper dry gas pools.

b. An amount trapped in the formation due to permeability barriers and irregular water invasion. This would be higher in the faulted Madison pools than in the highly permeable sand pools. In the Madison pools it may be as high as 10%, and in the dry gas pools as low as 1%.

c. Premature abandonment of wells due to mechanical failure. Possibly 1%.

d. Waste due to open flow tests and flaring of gas. Dry gas - 0.1%. Wet gas - 5%.

e. Well head and lease fuel - 1%.

f. Impurities in the gas which are removed. Dry gas - .5%. Wet gas - 5% to 20%.

TThose percentages can be obtained for the more important pools from the analyses which are included in Exhibit 3. An example for Morinville: Additional amount to take care of abandonment pressure of more than 100 pounds, 6.0%; trapped in formation 1.7%; premature abandonment 1.0%; flaring 0.1%; lease fuel 1.0%; impurities 0.2%, giving a total of 10%, which is the amount to be deducted from the proved reserves to 100 pounds to obtain the marketable gas.

You will realize that there are some items in there that are very difficult to calculate, and I claim no great amount of accuracy for any single item

in there.

Q They will vary from well to well?

A They will vary from well to well and from field to field.

Q But in the over-all picture the 10%, for instance, in the Morinville....

A Is a reasonable figure.

Q Is a reasonable figure?

A Yes.

Q Then there was a correction with regard to Page 46 of Exhibit 3, which you have included in this exhibit.

A Ih Exhibit 3 I confused two things under the heading "Calling Lake" and "Athadome No. 1", and I would like to make a correction here. Both sections should be deleted from the report, both sections under the heading of "Calling Lake" and "Athadome No. 1", and in their place the following should be placed: Athadome No. 1, about 20 miles east of the town of Smith, was completed in 1932, at a total depth of 1900 feet. The top of the McMurray was reached at 1720 feet, and a large flow of gas struck at 1765 feet in the McMurray. Another smaller gas flow of 120,000 cubic feet was encountered at 1160 feet. No additional drilling has been done in this area, and the information on the Athadome No. 1 well is very meagre. The prospects of finding a commercial gas field in this are very good. No reserves were assigned to this area because of the lack of data.

Q Then you have added also in this Exhibit a reference to the open flow capacity of the Picardville-Bon Accord area?

A Yes.

Q You can deal with that now?

Dr. A. W. Nauss,
Dir. Ex. by Mr. McDonald

A Several pools in the Picardville Bon Accord area exist in the Viking sand. These pools are: Picardville, Legal, Bon Accord and Excelsior. All of these pools are in the Viking sand, and, consequently, are believed to have similar producing characteristics, especially in view of the fact that the nature of the sand is similar in each case. For this reason, the one measured open flow of 26 million cubic feet at Picardville, is considered as an indication of what may be expected in all of these Viking pools. In none of the other pools has an open flow been measured, and the flows obtained on drill stem tests are not an indication of the open flow because of the small size of the bean in the drill stem test packer.

Although the pressures at Legal, Bon Accord and Excelsior have been listed in Table A as 765, 821 and 821 respectively, these pressures were not accurately measured pressures such as the one at Picardville, and, consequently, in estimating the open flow, less weight was given to the pressures than to the nature of the sand itself. At Legal, Bon Accord and Excelsior, the Viking is particularly well developed, and is of good quality - such that the porosity was estimated to be 23% rather than 21.5% as in Picardville. We, therefore, believe that the results obtained at Picardville are more or less what can be expected in the other Viking pools.

This interpretation has been confirmed to some extent within the past month by the results from Pacific-Excelsior No. 2 which blew wild at a rate estimated to be 20 and 30 million cubic feet per day. This well is being completed as a gas well, and definite tests will

be available on it in a short time.

Q Now, Dr. Nauss, you were dealing in this reference to the Viking sands in Picardville Bon Accord area?

A Yes.

Q And not to the Lower Cretaceous?

A Not to the Lower Cretaceous.

Q Now, you have prepared copies of the electrolog of Imperial-Excelsior No. 1 well?

A Yes.

THE CHAIRMAN: Before we go on, Mr. McDonald, if you don't mind?

MR. McDONALD: Yes.

Q THE CHAIRMAN: In that Pacific-Excelsior No. 2 that blew wild, was there any evidence of water in the gas?

A To start with, for the first, I don't remember the exact number of hours, but it was something like 12 or 15 hours, there was no water, and later there was a considerable amount of water coming up with it.

Q There was?

A Yes, there was a lot of water coming up with the gas in the later part of the period that it was flowing wild, and there was only ten feet of gas sand in the Viking, as is indicated by the electro log, so that with it blowing wide open like that, the water would come in quite soon. I do not believe that at that well itself that you would get a great deal of gas over a long period of time, because it has only 10 feet of sand, it is only ten feet thick, sitting right on top of water.

The point I wanted to make there was that the ten feet of sand produced at a high rate. The

quality of the sand is good.

Q MR. McDONALD: You are dealing here particularly with the porosity of sand and your estimate of 23%?

A Yes. In fact, the Pacific-Excelsior No. 2 well is on the edge of the area which I considered as the proved area of the Viking sand in the Excelsior pool, so that we have actually attributed no reserves to the Pacific-Excelsior No. 2 well.

Q Just for the record, you have prepared an abbreviated electrolog of the Viking gas sand in the Pacific-Excelsior No. 2 well. It is marked Item G in the envelope of the compilation exhibit?

A This item G.....

Q Just a minute, Dr. Nauss.

A It is labelled "Imperial Excelsior No. 1"....

Q It is Pacific-Excelsior No. 2 that we are dealing with first.

A There are two electrologs there. You will note at the top of the Viking, or near the top of the Viking, the perforated zone is shown there, and that is the zone from which Pacific-Excelsior No. 2 blew wild. You will notice that there is not a great deal of thickness there, and the perforation, the bottom of the perforation is very close to the water level where the curve on the right hand side jumps quickly to the left, so that the bottom of those perforations was not very far from the water level, and in blowing wild it brought in the water very quickly.

Q And then you have the electrolog of Imperial-Excelsior No. 1 well?

A The reserve shown for the Excelsior area is that around the Imperial-Excelsior No. 1 well, and you will note that I

have shown four drill stem tests. The drill stem tests are shown by cross-hatching on the inside of the log. The upper one from the top of the Viking to 2737 blew at 1717 Mcf. You will notice there are four drill stem tests, and the lower one had 30 feet of drilling fluid and had no gas. This Imperial-Excelsior No. 1 electrolog is given as supporting evidence for our reserve calculation on the Viking in the Excelsior pool.

MR. McDONALD: I suggest possibly, sir, these should be marked, first the Pacific-Excelsior No. 2 electrolog.

THE CHAIRMAN: That will be what? Imperial No. 1 was given a number before.

MR. McDONALD: No, that was not given a number, sir.

THE CHAIRMAN: Well, Pacific-Excelsior No. 2 electrolog will be marked Exhibit 84.

ELECTROLOG OF VIKING GAS SAND SHOWING PRODUCTION ZONE IN PACIFIC EXCELSIOR NO. 2 WELL MARKED EXHIBIT 84.

THE CHAIRMAN: And the other electrolog will be Exhibit 85?

ELECTROLOG OF VIKING GAS SAND SHOWING DRILL STEM TESTS IN IMPERIAL EXCELSIOR NO.1 WELL MARKED EXHIBIT 85.

A I think it would be well to point out that we did not gun perforate the very top of the Viking, and in view of the fact that it was productive in Imperial Excelsior No. 1 I believe it would also be productive in Pacific Excelsior No. 2, and that you could probably produce it without water, that is, the upper 10 or 15 feet of sand.

Q MR. McDONALD: Exhibit 84 shows the points where the perforations were made?

A Yes.

Q And your thought is that if the perforations were made further up the hole that you would have the Viking sand and that it would be productive?

A Yes, without water.

Q Without water?

A Yes.

Q And that has not been done?

A That has not yet been done.

Q Is that well being completed as a gas well?

A It is being commpleted as a gas well because in addition to that it has some Lower Cretaceous gas.

Q Now, Dr. Nauss, during the course of your previous examination, you were examined with regard to the thickness of the sand at the Morinville pool. I have not the references to the pages. But you were asked to submit the isopach maps that you referred to during the course of your evidence. And under Number (f) in this compilation of exhibits, is the isopach map of the gas sand in the Morinville pool.

THE CHAIRMAN: That will be Exhibit 86. .

ISOPACH MAP OF THE GAS SAND IN MORINVILLE POOL MARKED EXHIBIT 86.

Q MR. McDONALD: Would you just refer to that map, Exhibit 86?

A This is the isopach map upon which the original reserve estimate was based in exhibit 3, and it is an isopach map of net production gas sand in the Morinville pool, deducting all shale beds and all unproductive sand. The over-all thickness of those beds is greater than indicated by the contour map, but the non-permeable zones.

have been excluded, and the average thickness for the area is 40 feet. This is based on the three figures, Imperial Morinville No. 2 with 50 feet of net productive gas sand, Imperial Morinville No. 2 with 60 feet of net productive gas sand, and Pacific Calahoo No. 1 with 50 feet of productive gas sand.

Q You have arrived at the figure 40 on the basis of more than half of the contour area is above the 40 foot contour?

A That is not the way it is done. You measure the area above the 50 foot contour and that area will have an average thickness of 55 feet in this particular case, and you multiply the area you obtain by 55 feet,, then you planimeter the area between the 40 foot contour and the 50 foot contour, that is an average thickness of 45 feet, and you multiply the area you obtain by 45 feet, and so on, for the interval between 30 and 40 feet, and 20 and 30 feet, and 10 and 20 feet, and you add up all of those areas, multiply by the thicknesses, and that gives you the total volume, so that you obtain the total volume before you obtain the thickness. In order to obtain the average thickness, you divide the total area by the total volume and come out with the average thickness. It is a more accurate way of doing it than estimating the average thickness to start with.

Q MR. GOODALL: What sand is that?

A That is the Basal Quartz sand, the Lower Cretaceous.

(Go to Page 1314).

Q That is referred to in Table "A"?

A Yes.

Q I think another item that you were requested to give consideration to was a map of the Princess-Patricia area. No, just before we come to that, Dr. Nauss, the electrolog of the Imperial-Morinville No. 1. That was not included in your submission previously. You have obtained that. That is contained in the envelope, sir, as Item "B". It is the small electrolog. Have you any particular comment to make on that at this time?

A No, I don't. We discussed that at the last hearing in detail.

ELECTROLOG, IMPERIAL-MORINVILLE WELL NOW MARKED EXHIBIT 87.

Q Then we have marked "C" in the envelope, map of the Princess-Patricia area?

A Before we leave the Imperial-Morinville No. 1, there is another question I would like to refer to. We left out the scale on the chart, which includes the Imperial-Morinville No. 1.

Q That is Exhibit 11 you are referring to?

A That is Exhibit 11.

Q That is a correlation chart of the electrolog of the Morinville pool?

A Yes, and the scale of that chart is one inch equals 100 feet.

MR. McDONALD: The Chairman will recollect Exhibit 11 did not have on its face the scale on which it was drawn, and you asked if we would let you have the scale and Dr. Nauss has checked it and it is one inch - -

A One inch equals 100 feet is the vertical scale.

MR. McDONALD: I have included Exhibit 11 in this compilation for ready reference, but I did not intend to

refer to it today. Then we have the map of the Princess area and that will be - -

MAP NOW MARKED
EXHIBIT 88.

MR. SMITH: What is the letter number?

MR. McDONALD: "C". The next one is a map of the Pakowki Lake area, or the Pendant d'Oreille area is another name for it. That will be Exhibit 89.

MAP IN QUESTION
NOW MARKED EXHIBIT 89.

Q Dealing with Exhibit 88, Dr. Nauss, will you explain what - that will be the Princess area - will you explain how you arrived at the areas and the meaning of the different colours?

A These are the areas referred to in Dr. Hume's report of given reserves.

Q They are also referred to in your Table "A"?

A Yes. Yes, they are referred to in my Table "A". The area outlined in brown is the area productive in the Basal Alberta sands. There are two areas outlined in yellow and those are the productive areas in the Sunburst sand and the area outlined in green is the productive area of the Jefferson.

Q And the acreages?

A The acreages of those four areas are given on Table "A". The Basal Alberta is 19,200, the Lower Cretaceous or Sunburst is 8,350, the Patricia, 1920 and the Jefferson, 7,500 acres.

Q And Exhibit 89?

A That is the productive area in the Pakowki Lake area. The total there is 58,250 acres.

MR. McDONALD: Mr. Chairman, I have included in this envelope a photograph of the Exhibits we had on the board. I do not know whether it will be worthwhile to mark it as an exhibit. It shows the coloring, the correlation of the electro-

log on Exhibit 11.

THE CHAIRMAN: You say it is a photograph of the exhibits already in?

MR. McDONALD: It is a photograph, a composite of all of the exhibits we had pasted on the board during the last hearing.

THE CHAIRMAN: We can put it in and give it an exhibit number.

PHOTOGRAPH NOW MARKED EXHIBIT 90.

MR. McDONALD: All the items in this photograph have been filed as individual exhibits.

MR. MAHAFFY: There is a picture of the Legislative Assembly in the background. Does that have any significance?

MR. McDONALD: The balance of the items in this booklet are exhibits that have already been filed, but I have compiled them here for the information of those who may be interested. I may say, sir, that the maps and electrologs, particularly those which were referred to in the photograph, have been reproduced and included in the envelope. I have included the items which were presented in sheet form by Dr. Dodge, Mr. Sample, and by Dr. Hetherington, and also the estimated peak day requirements of the Canadian Western system. I think there is one item I wish to refer to and that is Exhibit 30, the map of the Viking gas pool.

A Yes.

Q That is Exhibit 30 in the binding.

A On top of the Redwater field there is quite a nice gas pool developing in the Viking, and this area outlined on Exhibit 30 is the status of that development as of the beginning of the last hearing. There are a number of additional wells

have been completed that increase that area by a very large amount. Royalite have recently been drilling three wells in the Southeastern corner of this map and they, in all three of those wells, made tests in the Viking and obtained substantial gas blows; so it extends that area all the way down to the Southeastern corner of the map, the area at least being double at the present time, which would double the reserves in the Viking. But we have not recalculated that as yet.

Q The area you have in your Table "A" is 5600 acres?

A Yes, that is the area shown on Exhibit 30.

Q And there will be considerable added to that following recent completions?

A Yes.

MR. McDONALD: I hope that completes the total replies of Dr. Nauss to the things he was requested from time to time to obtain. If there is anything we have missed I hope other counsel and the Board will assist me, and we will be glad to deal with it.

THE CHAIRMAN: Dr. Hetherington will deal with deliverability?

MR. McDONALD: Yes, we are making an entirely new submission on deliverability. Since the date of the last hearing, additional completions of wells have occurred and Dr. Nauss has prepared a further submission for the purpose of bringing the picture up to date. I submit, sir, this submission: "Additional Data on Reserves with Particular Reference to Developments since the Adjournment of the Gas Hearing on February 17th, 1950."

DOCUMENT IN QUESTION IS
NOW MARKED EXHIBIT 91.

Q Will you read that?

A

Submission of Additional Data on Reserves with Particular Reference to Developments since the Adjournment of the Gas Hearing on February 17, 1950.

General

Since the adjournment of the Hearing before the Petroleum and Natural Gas Conservation Board last February, additional wells have been completed which have made important gas discoveries. Those areas with a sufficiently thick gas reservoir and on which sufficient information is available to indicate the presence of gas in commercial quantities, have been outlined and their reserves calculated.

A study was made of the occurrences of gas in the Lower Cretaceous in the Leduc Field. It was found that the gas occurrences have a rather irregular distribution in this field due to the lenticular nature of the individual sand beds. Such lenticularity might be a disadvantage in an area outside of the Leduc Field where wells had to be drilled for gas alone. Such a pool might be uneconomical in another area due to the fact that a large percentage of dry holes would have to be drilled in order to outline the different small pools with irregular limits. However, in the Leduc area, where a large number of closely spaced wells have already been drilled for oil, and where the cost of those wells does not have to be written off against the gas, it is believed that the gas occurrences in the Lower Cretaceous are definitely of commercial importance, especially when it is considered that the gas can be made available merely by gun-perforating the casing in the present wells when the oil reservoirs are exhausted.

Within the past few months a number of wells have

been drilled which had important gas shows, but which cannot be evaluated at the present time due to insufficient data. These occurrences have also been listed.

Additional information has been made available on the Battleview pool which confirms our previous reserve estimate. The new data on this pool and the new calculations are included here. The Battleview pool along with the Vermilion pool is presently supplying the town of Vermilion.

At the first part of this Hearing, a total recoverable reserve of 6,117 billion cubic feet of gas was reported in the revised Table "A" of Exhibit 3. Developments and revisions since that time have added an additional 129 billion cubic feet of recoverable reserves, or 162 billion cubic feet of gas in place. This increases the recoverable reserve to 6,246 billion cubic feet. The list of the new reserves is as follows: Excelsior, 33 billion cubic feet in place, 80% recoverable and the total recoverable volume is 26 billion. Jarvie, 39 billion in place, 80% recoverable and the total recoverable volume, 31 billion. Oyen, 27.4 billion in place, 80% recoverable, total volume recoverable, 22 billion. Spedden, 12 billion in place, 75% recoverable, and the total volume recoverable, 9 billion. Leduc, 50.7 billion in place, 80% recoverable and a total recoverable volume of 41 billion. The previously reported recoverable volume was 6,117 billion. The present figure is 6,246 billion cubic feet.

Now follows a description of the individual pools. The Battleview Area. I would like to refer to the map of the Battleview pool in the back of the exhibit. This map is a seismic map converted to depths and taking into consideration the depths at the three wells shown on the Battleview structure.

The first area dealt with here is around V.C.O. No. 3 well, and the productive area, the proved productive area, is shown by a dash line around that well. The producing sand is the Colony sand which marks the contact between the Alberta group and the Lower Cretaceous formation and produces gas in this area. The thickness of this sand, equal to 6 feet, was obtained from the Lane Wells radioactivity log, drill stem test, and from the perforated interval. Porosity and Connate Water were obtained by comparison with neighbouring wells. The Temperature was taken from Table "A", on Exhibit 3, and is 63 degrees Fahrenheit in the reservoir. The pressure readings were measured top hole pressure readings. The pressure readings were taken during tests made at the well and converted to absolute values. The deviation factor of 0.90 has been taken from charts given by A.B. Brokaw in his paper "Correction of Gas Volumes for Compressibility and Temperature". That paper appeared in the Petroleum Transactions American Institute of Mining Engineering Number 2698, September 1949. The area as shown on the accompanying map is 2,000 acres around the well site. The calculation showing these figures is presented here on page 3. I will not go into these calculations unless someone wishes me to. That gives a total of 3,554,496 Mcf. of gas in place.

Battleview Area "B" is the southern area shown on the map and there are two productive gas wells, V.C.O. No. 4 and V.C.O. No. 11. The results of those wells were stated in Exhibit 3. V.C.O. No. 4 is an old well that was previously called Western Battleview No. 1. During the past summer it was cleaned out and tested and found to have an open flow of 68 million cubic feet of gas per day. In addition a Lane Wells

radioactivity survey was run of V.C.O. No. 11 and that well was tested and is a successful gas well. The location of those wells and their elevations is shown now on page 3. The producing sand is the same, the Colony sand and a thickness of 23 feet has been used. This thickness was determined in V.C.O. No. 11, one-quarter of a mile to the northeast of V.C.O. No. 4, and was determined on the radioactivity log in conjunction with perforation tests. You can determine that on the radioactivity log because of the neutron curve. The curve takes a jump to the right showing increased radiation. The thickness can be obtained from that curve. The reason for the increased radiation is that the gas sand presents less of a barrier to the neutrons as they penetrate into the formation and more getting into the formation cause gamma ray radiation. Porosity and Connate Water were obtained by comparison with neighbouring wells. The Temperature was taken from Table "A" of Exhibit 3 and is 63 degrees Fahrenheit. The pressure readings were taken during tests made at the well and converted to absolute values. There is a deviation factor of 0.90 as shown from the charts. An area of 2,511 acres has been calculated as proven. The downdip limit of the pool was determined by the contour where the top of the sand had dropped an amount equal to the thickness of gas-bearing sand, that is, 23 feet. The updip limit was taken as lying a mile updip from the wells.

You will note that the whole area of the structure has not been considered as productive and the reason for this is the discontinuity of the sands in that area. It would take several more wells to prove the entire structure was productive. The calculations follow there and the gas in place in this

Area "B" is 17,147,513 Mcf. The two add up to 20.7 billion and the recoverable reserve at 80% recoverable is 16 billion cubic feet.

Q Just on that point of recovery, Dr. Nauss, and if you refer to Table "A", if this calculation had been carried out on the same basis as Table "A", you would have taken your total reserves of "A" and "B", 20,702,009 Mcf. to 100 pounds abandonment pressure and then taken your percentage?

A Yes, that is right.

Q In lieu of that, you have taken - the percentage there was 90%?

A That is right.

Q And in this case you have taken 80% of gas in place instead of taking into account an abandonment pressure down to 100 pounds?

A This also includes an abandonment pressure of 100 pounds. This method of treatment is the more common one in calculating gas reserves.

Q THE CHAIRMAN: This merely replaces the information in revised Table "A"?

A No, it does not. This is in addition to it. In regard to Battleview it replaces it, yes, but in regard to the other pools here it is in addition to revised Table "A".

MR. McDONALD: I might point out the information was not available to us in December and January and was made available immediately after the hearing and was recalculated.

A You will notice the reserve of 16 billion and that is the recoverable reserve we show on Table "A" and the two check.

The Excelsior field, Basal Quartz. The reserves are included in Table "A". Four wells located in the Excelsior field have indications of gas, and these, along with the other wells which have been drilled in the area, serve to delineate

a gas pool in the Basal Quartz sandstone member of the Lower Cretaceous. The gas tests in the four wells are as follows. These four wells are plotted on the map for the Excelsior area in the back of the report. Imperial Excelsior No. 1. The first drillstem test was from 3515 to 3532 and the valve open 60 minutes and the recovered gas was 25 Mcf. with 10 feet of mud. The next test area was from 3533 to 3543, valve open 60 minutes and the gas on that drillstem test was 1632 Mcf. Continuing on down they got no more gas but they recovered oil instead.

Q You are referring to Imperial Excelsior No. 2 and not No. 1?

A No, that is Excelsior Imperial No. 2, yes.

Q You said "1"?

A If I said "1", I meant "2". The second well is Pacific Excelsior No. 1. Location is Lsd. 13, section 2, township 56, range 24 West of the 4th Meridian. This is plotted on the map. The zone was not tested in this well. However, the electrolog showed indications of gas in this zone and it was upon this basis that the zone was tested in Pacific Excelsior No. 2. We thought the electrolog indicated gas so we tested Pacific Excelsior No. 2. We tested at a depth of between 3465 and 3480, valve open 66 minutes and gas blew out 2,365,000 cubic feet per day and 30 feet of mud was recovered. The electrolog of that well is included in the illustration at the back of the report. Pacific Excelsior No. 2, and you will notice on that the interval tested is shown.

(Go to page 1324.)

Q THE CHAIRMAN: Was that a recent test, Dr. Nauss?

A Yes, that was before the well blew wild.

Q Before?

A Yes, before the well blew wild.

Q On the basis of what?

A Well, this is what we did. We drilled the well into the D-2 and it was a dry hole, it was too low. While we were drilling we took a drill stem test of the Basal Quartz sand and that is the drill stem test that is reported here. Then we plugged off the D-2 at the bottom of the hole and we had a casing set in the hole. We came back up and gun perforated the Viking. We had a drill stem test. We tested those perforations with a drill stem test with a packer set just above the perforations and obtained nothing on the drill stem test, no gas blew at all, so we thought that there was not any gas in the Viking. So then they proceeded to bale the well dry and in doing so they had to take off the blow-out preventer.

Q Have you had a chance to test the Basal Quartz?

A We have not tested it, no.

Q You have not had a chance to?

A Since the blow-out, no, but we are going to. The fourth well is Calmont-Excelsior No. 6. You will note that on the map that is at the northeastern edge of the proved acreage. Two drill stem tests were taken in the Basal Quartz in that well, one from 3515 to 3532. The valve was open 60 minutes and a gas flow of 25 Mcf. was obtained. The second flow was from 3533 to 3543. The valve was open 46 minutes and a gas flow of 1,632,000 cubic feet was obtained with a recovery of 18

feet of mud. There is no water in either of those tests. The electric log of Calmont-Excelsior No. 6 is included and you will notice that the tested interval is in the lower part of the gas sand indicated on the electric log, so that the substantial thickness is shown there. The map of the Excelsior area, this is a contour map on top of the basal quartz sand, based on wells, and since there are quite a number of wells that contour map is quite reliable. You will notice that it shows a nice dome shaped structure, which was the reason for drilling the wells in the first place, and that Imperial-Excelsior No. 1 was tested in the Basal Quartz sand and obtained water, did not obtain gas. Imperial-Excelsior No. 2 immediately north did obtain gas so the water line runs between those two wells. Imperial-Excelsior No. 1 encountered the top of the quartz sand at -1190, so that the water level is in the vicinity of -1190 at that well. However, since Pacific-Excelsior No. 2 encountered the gas below -1189, the water level there is still lower, so the water level is not level. That is a very common thing. The water line is outlined on this map on the basis of all that information.

Q MR. McDONALD: Which is the water line on the map?

A The water line is the heavy line indicated by dash and a dot, dash dot. There is an additional well Rio Bravo Carruthers No. 5-3 there which obtained gas in the Basal Quartz sand as well. They hit the top of the Basal Quartz sand high, and that is the reason for the gas.

The basis of the data is all

included there, as I just explained, and the calculations of reserves are also included giving the recoverable reserve for that area of 26 billion cubic feet. That is a rather well substantiated reserve.

(The Hearing then took a short adjournment.)

Q MR. McDONALD: I think you were at page 6, Dr. Nauss.

A The next area is the Jarvie area. Imperial-Jarvie No. 1 located 26 miles northeast of Barrhead. Markers, Viking 2218, Lower Cretaceous 2327, Basal Quartz 2960. Drill stem tests 2216 to 2242 in the Viking zone, valve open 54 minutes, gas flow 1,204,000 cubic feet per day with no fluid. The next test in the Glauconitic sandstone 2868 to 2884, valve open 60 minutes, gas 4066 Mcf. per day, no fluid. The next one is 2868 to 2894 in the Glauconitic sandstone, valve open 60 minutes, gas flow of 4,287 Mcf. per day. That is continuing on in the same zone. Then another test deeper, 2959 to 2969 in the Basal Quartz sand, 55 minutes the valve was open, gas 3130 Mcf. per day; 2969 to 2977 in the Basal Quartz, valve open 35 minutes, gas 2,802 Mcf. per day; 2976 to 2984 in the Basal Quartz zone, valve open 45 minutes, gas 3,619 Mcf. per day. There was no fluid recovered but on that test a small amount of salt water occurred with the gas, it blew up with the gas when the gas was blowing. 2984 to 2992 in the Basal Quartz, the valve was open 46 minutes, there was no blow, and 720 feet of salt water was recovered. That shows that the bottom of the gas sand is about at 2984.

There are three separate gas sands in the well, the Viking, the Glauconitic, and the Basal Quartz sands. The electric log is shown at the back of the report, Imperial-Jarvie No. 1. The drill stem tests on this electric log are shown by those cross-hatched areas and the amount of gas blow is written in at the left. This shows just the two gas sands in the Lower Cretaceous. The thickness of these sands measured on the electric log and indicated by the drill stem tests are as follows: The Viking 7 feet, Glauconitic sandstone 16 feet, the Basal Quartz sand 20 feet. The Viking in Imperial-Jarvie No. 1 appears on the electric log to be more poorly developed than it is at Picardville 35 miles to the southeast. The measured porosities at Picardville in the Viking averaged 21.5 per cent. The comparison suggests that the porosity would be about 15 per cent and the connate water about 25 per cent.

A similar comparison has to be made for the other two sands since core analyses are not available. Certain comparisons give the following results: Glauconitic 18% porosity, connate water 25%; Basal Quartz sand 20% porosity and 22% connate water.

Pressures. - Since this well is still drilling, measured shut-in pressures are not yet available, consequently pressures must be estimated. This can best be done by considering the depth of gas sand. The pressure in the gas sands of Alberta are in general close to the hydrostatic head at that depth. It is rather interesting to plot the pressures of the gas sands against depth, and there is a fairly close relationship. The hydrostatic head at the depth is very close to the pressure obtained. We

decided that it would be conservative, in view of the fact we had no measurements, to take 80% of the hydrostatic head rather than the total hydrostatic head, and that gives these pressures: Viking 770 lbs. per square inch absolute, Glauconitic 1,000 per square inch absolute, and Basal Quartz sand 1025 lbs. per square inch absolute obtained by that method.

Temperatures were calculated from the geothermal gradient as follows: Viking 73 degrees, Glauconitic 83 degrees; Basal Quartz 85 degrees. Only one well has been drilled in that particular area so we have taken as proved a circle having a 1 mile radius, giving 2000 acres.

The deviation factor using the pressures listed here and the temperatures listed here, and assuming a specific gravity of .6 for the gas -- that is a good average specific gravity for dry gas -- and using the charts compiled by Brokau, you obtain these deviation factors: Viking 0.89; Glauconitic 0.86; Basal Quartz 0.86.

On page 8 we have the calculations of the reserves. Using those figures for the Viking, we have a gas in place of 4 billion; the Glauconitic gas in place 14 billion, and the Basal Quartz sand gas in place of 21 billion. That gives a total gas in place for the Jarvie well of 39 billion, and considering 80% of that recoverable you get 31 billion.

The next area is Oyen. The reserve at Oyen is based on Hudson Bay Sparky No. 1 in Lsd. 4, Section 12, Township 29, Range 5, West of the 4th.

Dr. A. W. Nauss - Dir. Ex.

Drill stem tests from 2584 to 2589, valve open 13 minutes, a gas flow of 3600 Mcf. with no fluid recovered. A second gas test of 2598 to 2611, the valve was open 40 minutes, and the gas flow 2430 Mcf. with 10 feet of water. The electric log showing those tests is in here, Hudson Bay at the back under Hudson Bay Sparky No. 1. You will note there that the gun perforated intervals in the Viking is also shown, and the interval was from 2588 to 2613 and was perforated with three shots per foot and it produced 6800 Mcf. after being swabbed in with 2½ inch tubing. That production was through 2½ inch tubing.

Producing Sand - Gas is produced from the Viking sandstone of the Alberta group.

Thickness - The Thickness of this sand, equal to 28 feet, has been obtained from the electric log, tested interval and core descriptions.

Porosity and Connate Water - Porosity is estimated at 20% and the Connate Water at 20% from the electric log.

Temperature - The formation temperature of 78.8 degrees Fahrenheit was calculated from the geothermal gradient.

Pressure - The pressure is estimated at 898 feet, 898 lbs. per square inch, by calculating 80% of the hydrostatic head. An area of 2,000 acres around the well site has been taken as proved, and using these figures of reserve calculations, the gas in place is 27 billion cubic feet, and recoverable reserves estimated at 80% of gas in place is 22 billion cubic feet.

Q The electric log is in the back?

A Yes, the electric log showing the drill stem tests and the gun perforated intervals is shown in the back. On that electric log I believe the third curve is unreliable. It is shown as a straight line there and it looks as if the curve is not working.

The next area is Spedden. This area is based on the well Bailey Spedden No. 1. The location is 10 miles west of the gas discovery, Angelus Ashmont No. 1, which we reported in Table "A". This well was completed on February 21st, 1950. The Viking was encountered at a depth of 1431 feet, and the Lower Cretaceous at 1562 feet. One drill stem test was taken in the Lower Cretaceous from 1605 to 1625, the valve was open 60 minutes, and the gas blow 750 Mcf. was obtained, with a 15 foot recovery of mud. Casing was set on the well and the interval from 1570 to 1582 was gun perforated with 24 shots, tested the perforated interval with a drill stem test, that is, a packer was set above the perforations using drill stem, and a maximum flow rate of 3,000 Mcf. per day was obtained. The electric log of this gas sand is included, Bailey Spedden No. 1. The perforated interval is shown there, and you will note that the gas sand shows up rather clearly because of the high resistivity. It is the upper sand of the Lower Cretaceous. The Colony sand, that is, the same sand that produces in Angelus Ashmont No. 1, the gas sand in this well is at the top of the Lower Cretaceous. Its thickness, as measured on the electric log, and indicated by tests, is as follows: Upper Sand - 20 feet. That is the Upper Sand of the Lower Cretaceous.

Porosity and Connate Water - The top sand of the Lower Cretaceous is a fine grained, well sorted soft sand, and consequently the porosity is high. Such sands usually have a porosity of about 25%, because it is well sorted. The porosity and connate water of this sand has been estimated at 22% and 20% respectively.

Pressure - 80% of the hydrostatic head equals 540 pounds.

Temperature - 63 degrees calculated from the geothermal gradient as shown there.

Area - 2,000 acres, and the deviation factor from the chart is still .93.

The calculation of the reserves in place is 12 billion, and estimating that 75% of this will be recoverable that would be 9 billion. The reason for the lower recovery rate here is because the pressure is lower and a larger percentage of the gas will be left in the ground at the abandonment pressure.

Now, that covers the new discoveries, that is, those wells upon which the data is sufficiently reliable that reserves can be calculated.

This next, Leduc, Lower Cretaceous. At the previous Hearing we had not yet calculated the reserves of the Lower Cretaceous at Leduc due to the large amount of work involved. In the meantime, we have completed that calculation of the reserves in the Lower Cretaceous and they are presented here.

The Lower Cretaceous formation in the Leduc Field contains well developed gas-and-oil bearing horizons. Although these horizons consist of lenticular

sand zones, which are not continuous over a very great area, appreciable gas reserves are present. Commercial production of these reserves is assured, as most of the subsurface development and surface installations are already completed for the present production of oil from the Devonian reservoir. These can be converted to gas production with little additional cost when the Devonian reservoir is depleted.

Gas-bearing Horizons - The main gas-bearing horizon occurs at about -1950 feet elevation, approximately 550 feet below the top of the Lower Cretaceous. The reservoir consists of a lenticular sandstone bounded by stringers of shale (see cross sections A-B and C-D). That is the last illustration in the report and it is folded. I say the two cross-sections shown on this, the No. 1 A-B. No. 1 A-B shows 4 electric logs in those 4 wells. One of them was tested in the sand in question, which was Imperial-Leduc No. 171. If you look at the electric log of 171 you will notice that 4 drill stem tests were taken in the gas sand and there were 4 gas blows. On the last test 150 feet of oil was recovered and that is interpreted to mean that the gas is resting on oil. A very small amount of oil occurs in the bottom of the sand.

Now, you will notice on Imperial Leduc No. 179 at the right hand of the profile that the gas sand is very poorly developed on the electric log, and that is considered as lying outside of the area. On Imperial-Leduc 175 that sand was not tested, but you will notice that the electric log showed a good development of sand, and in addition the sand occurred at a higher level. A -900 elevation

line has been drawn here, and all of these electric logs have been placed in their proper position with respect to those lines.

Q -1900?

A Yes, -1900. At Imperial-Leduc 15 you will notice that sand occurs at a higher elevation than it does at 171, and it has a high resistivity indicating the presence of gas again.

Now, on the cross-section profile C-D there are 4 wells. The Imperial Leduc No. 173 is the only one that had a drill stem test containing gas. In fact, it was not this well that was tested but it was its twin well just a few feet away which was tested, and that drill stem test yielded 1280 Mcf. You will notice that it is in the lower part of the sand indicated by the electric log. The Imperial-Leduc 228 is the only other well that has definite gas sand as indicated by the electric log, and it occurs at the same elevation as Imperial-Leduc 173, so we have interpreted that that well has a gas sand in it, that that gas sand would be productive in that well. It has not yet been finished. In Imperial Leduc 158 the electric log shows that the sand is probably wet. It may contain gas but the electric log does not definitely prove that, so we have excluded it from the proved area. On Imperial-Leduc 177, which is the left hand electric log on there, you will notice that there is a high resistivity on the right hand side of the log, and I believe that is probably gas sand there but because it is so far from a tested well and because there is a log which looks unproductive in between, we have excluded that also from the proved area. We can not consider it at the present time proved.

Now, selection of those cross-sections. Those two cross-sections are shown on the map which immediately precede that cross-section. The cross-section A-B, before going through the 4 wells, is shown in the centre of the map going from east to west, and the cross-section C-D is shown at the south part of the map and extending from north to south. That cross-section is placed here to show the manner of calculating the reserve in this pool. We have taken the electric logs and also the drill stem tests on all of the wells whose electric logs indicate gas, and while that was drill stem tested, that was considered as being a productive well and the area indicated by those wells has been outlined.

(Go to Page 1335)

In the Gilbert pool, two miles to the northeast of the Leduc field, 10 wells are producing gas and oil from this sand. That is the main gas-bearing sand. In the northeast corner of the Leduc field itself, production from this sand is taken by Central Co-op. 5-C. The presence of gas in this sand has been established by drill stem tests in several wells throughout the field. Oil was found only in minor quantities close to the water line. In this report this horizon is indicated by sand "A". The outline of the productive areas, indicated A-I, A-II, A-III, and A-IV, and the thickness of the reservoir was obtained from electric logs. Those four areas are shown on the map. T y are marked A-I, A-II, A-III and A-IV right at the southern part of the map.

Two other gas-bearing sands having minor development occur approximately 450 and 200 feet below the top of the Lower Cretaceous. Sand "B" is located in the centre of the field, and Sand "C" in the southeast corner.

SPECIFIC GRAVITY, RESERVOIR PRESSURE AND TEMPERATURE

The specific gravity of the gas in Central Leduc No. 7, in the Gilbert pool, was found to be 0.74. This gas is produced simultaneously with oil from sand "A". In the reservoirs under discussion, where oil occurs only in a small section of the sand, a specific gravity of 0.65 has been assumed.

The reservoir pressure measured in Sand "A" of the Gilbert pool is 1400 p.s.i. Bottom hole pressures recorded in a few drill stem tests elsewhere in the field indicate that the same pressure is also

applicable to the remaining reservoirs discussed herein.

The r eservoir temperature of Sands "A" and "B" has been taken as 130° Fahrenheit. This corresponds with the temperature recorded in Sand "A" of the Gilbert pool. The temperature gradient indicates a temperature of 125° Fahrenheit for "C".

ESTIMATING POROSITY AND CONNATE WATER

With the exception of that in Central Co-op. 5-C, no core analysis data of the Lower Cretaceous sands are available. Porosity and connate water have been estimated by use of data supplied by the electric log and by core and sample descriptions.

CALCULATIONS OF GAS VOLUMES

The net reserve in place and the amount of gas remaining in the formation at 200 pounds abandonment pressure have been calculated.

(1) Sand A-I. That is the small pool on the northeastern edge of Leduc. The area there is shown on the map as 190 acres, thickness 30 feet, porosity 0.2. The porosity there is shown as a decimal. That is not 0.2%, that is 0.2 porosity. Connate water 0.2. Pressure 1400 p.s.i. Temperature 130° Fahrenheit. Deviation factor at 1400 pounds is .85. Deviation factor at 200 pounds abandonment is .97. TThe calculation based on those figures gives 4 billion approximately of gas in place. The gas left in reservoir when the pressure was 200 pounds will be 500 million, half a billion, leaving 3½ billion cubic feet in that area.

The second area is marked on the map as A-II. These areas can be very well outlined because of the large number of wells and the estimation of the area is quite accurate. The factors used are, area 1820 acres, thickness 26 feet, porosity 0.2, connate water 0.2, pressure 1400 pounds, temperature 130°, deviation factor at 1400 pounds, .85, and deviation factor at 200 pounds .97. That gives gas in place of 33,276,968,000 cubic feet, and the gas in reservoir at 200 pounds is 4,155,498,000 cubic feet.

The next area is Number III.

Q MR. McDONALD: Sand A-III?

A The Sand is Sand "A", and the first letter refers to the sand, and they are all sand "A", and the second Roman numeral refers to the area. A-I is Area I, A-II is Area II, Sand "A", and A-III is Area III, and Sand "A".

This area has 160 acres, thickness 35 feet, porosity 0.2, connate water 0.2, pressure 1400 pounds per square inch, temperature 130° Fahrenheit, deviation factor at 1400 pounds is .85, and deviation factor at 200 pounds is .97, giving gas in place of 3,938,102,000 cubic feet, and the gas in the reservoir at 200 pounds, that which is left in the reservoir at 200 pounds, is 491,774,000 cubic feet.

The fourth area in sand "A" shown at the bottom of the map includes four wells. The area is 114 acres, the thickness 30 feet, porosity is 0.2, connate water 0.25, pressure 1400 pounds per square inch absolute, temperature 130° Fahrenheit, deviation factor at 1400 pounds .85, and the deviation factor at 200 pounds is .97. The

gas in place is 2,254,739,000 cubic feet. The gas in the reservoir at 200 pounds is 281,563,000 cubic feet.

Now, that is the last of four different areas in the one sand "A".

Now, sand "B". There is one area in Sand "B", which is within the area of Sand "A". It occurs underneath it in the same wells. There are three wells in that area. The area is 60 acres, thickness 24 feet, porosity 0.1, connate water 0.3, pressure 1400 pounds per square inch absolute, temperature 130° Fahrenheit, deviation factor at 1400 pounds is .85, and the deviation factor at 200 pounds is .97. That gives a gas in place of 421,939,000 cubic feet. The gas left in the reservoir at abandonment pressure of 200 pounds is 52,690,000 cubic feet.

The final area, Sand "C", which is a different sand down in the southern part of the pool, and it is a small gas pool. The cross-section is the one that we looked at. That area is 330 acres, thickness 45 feet, porosity 0.15, connate water 0.7, pressure 1400 pounds, temperature 125° Fahrenheit, deviation factor at 1400 pounds is .85, and the deviation factor at 200 pounds is .96. That gives you a gas in place of 6,816,961,000 cubic feet. The gas left in the reservoir at 200 pounds abandonment pressure is 851,275,000 cubic feet.

Now, adding all those figures together for all the different areas, you get a total gas in place of 50.7 billion cubic feet, that is, dropping all insignificant figures. The total unrecoverable gas at 200 pounds abandonment pressure is 6.3 billion cubic feet,

dropping the insignificant figures. That gives 12.4% of the total reserve as unrecoverable at 200 pounds abandonment pressure.

Additional gas losses due to premature abandonment of wells, trapping in the formation, lease fuel, etc., are estimated at 7.6% of the total reserves, and are equal to 3.8 billion cubic feet. So that gives you a total of gas in place of 50.7 billion cubic feet, total unrecoverable gas of 10.1 billion cubic feet, or a net recoverable gas of 40.6 billion cubic feet.

Now, in addition to those areas which have sufficient information on them so that we could calculate the reserves, within the past two months there have been other gas discoveries, some of which may indicate the presence of appreciable gas reserves, others of which may be of no value whatsoever, because we are unable to evaluate these at this time, so that we merely list them here.

The first one is Socony Vegreville No. 1, location L.S.D. 14, Section 20, Township 51, Range 15, West of the 4th. The sand there is the Viking, which was drill stem tested from 2166 to 2215, the valve was open 60 minutes, and the gas flow of 1024 Mcf. per day was obtained.

Pan Western Edmonton No. 2, a well which is west of the City of Edmonton, in L.S.D. 9, Section 24, Township 52, Range 26, West of the 4th, was tested in the Lower Cretaceous from 4060 feet to 4074 feet, the valve was open 60 minutes, and the gas flow was 1070 Mcf. per day.

THE CHAIRMAN: Mr. McDonald, unless Dr. Nauss has any particular comment to make, can't we take those as read?

MR. McDONALD: Yes, we can do that.

THE CHAIRMAN: Unless there are some comments Dr. Nauss wishes to make.

MR.McDONALD:: Yes, sir, we will do that, and if there are any comments he wishes to make he can do so.

THE CHAIRMAN: Yes.

Hudson's Bay Winnifred #1.

Sand: Lower Cretaceous

D.S.T's 3159-3193 V.O. 35 mins . Gas flow - 2000 Mcf.per day. Rec. 150' of mud.
3181-3193 V.O. 35 mins . Gas flow - 2000 Mcf. per day. Rec. 120' of mud.
3180-3208 V.O. 33 mins. Gas flow - 2600 Mcf. per day. Rec. 180' of mud & water, 30' of oil.
3181-3228 V.O. 200 mins. Continued gas blow. Rec. 630' of oil

Cal.Standard Claresholm Province #1A

Location: Lsd. 3-12-13-26 W.4th.

Sand: Basal Cretaceous - "Sunburst"

D.S.T. 6473-6512 V.O. 60 mins. Gas flow -1040 Mcf.per day.

Imperial Willingdon #2

Location: Lsd. 11-20-55-15 W.4th.

Sand: Basal Quartz S.S.

D.S.T.'s 2181-2188 V.O. 30 mins. Gas flow -1380 Mcf.per day.
2187-2193 V.O. 30 mins. Gas flow -1380 Mcf.per day.
2193-2198 V.O. 50 mins. Gas flow -1280 Mcf.per day.
2198-2205 V.O. 45 mins. Gas flow - 256 Mcf.per day. rec. 270' of salt water.
(See copy of electric log.)

Pacific Deadman #1

Location: Lsd. 7-32-56-27 W.4th.

Sand: Viking

D.S.T. 3009-3018 V.0.75 mins. Gas flow - 2530 Mcf. per day.

Bear Brandi #1

Location: Lsd. 9-23-66-22 W.4th.

Producing horizon: D-1 zone

D.S.T. 2052-2074 V.0.44 mins. Gas flow-2630 Mcf.per day.

Remarks: Still drilling.

Trend Royalite Bolloque #1

Location: Lsd. 8-22-64-26 W.4th.

Sand: Lower Cretaceous.

D.S.T.'s. 2796-2826 V.0. 89 mins. Gas flow - 776 Mcf.per day.
2872-2880 V.0. 60 mins. Gas flow - 1906 Mcf.per day.
2875-2888 V.0. 60 mins. Gas flow - 2040 Mcf. per day.

Remarks: Not yet completed - still drilling.

Imperial Plain Lake #1

Location: Lsd. 1-11-52-12 W.4th.

Sand: Lower Cretaceous.

D.S.T. 2190-2212 V.0.30 mins. Gas flow-4500 Mcf.per day.

Imperial Waybrook #1

Location: Lsd. 4-32-57-24 W.4th.

Sand: Basal Quartz member of the Lower Cretaceous

D.S.T. 3340-3350 V.0. 75 mins . Gas flow -4997 Mcf.per day. no water.

The results of this test, together with the electric log,indicate that there is a gas sand here having a thickness of 30 feet in the Basal Quartz sand (see accompanying copy of electric log).

Imperial Waybrook #1 also encountered gas in the Viking. This occurrence w as reported on previously but a copy of the electric log of the Viking sand is included.

Q MR. McDONALD: Dr. Nauss,I think you want to discuss Imperial No. 1?

A Yes. I would just like to say a word with regard to Hudson's Bay Winnifred No. 1 well. You will notice that there were three drill stem tests in that well in the Lower Cretaceous. That well is just a few miles southeast of the Bow Island storage field, and I think that is a significant gas discovery in view of the fact that the well is close to the Bow Island storage field.

California Standard Claresholm Province No. 1A is south of Calgary, between Calgary and Macleod, and it had a successful drill stem test but only a small flow.

I would like to comment on Pacific Deadman No. 1. We drill stem tested the Viking and got a gas flow of 2,530,000 cubic feet per day through a thickness of 4 feet. There was only four feet on the electric log, and there was no water in the sand, and the bottom of the sand was separated from the main part of the Viking by a shale break, but we calculated the reserves or the amount of gas that might be produced through that well, and decided that it would be too small to justify setting pipe on it and waiting for a considerable period for the return on your money, and our calculations turned out uneconomic, so that we abandoned the well.

I have a comment to make on Bear Brandi #1, which is a short distance east of the town of Athabasca. The drill stem test listed here is in the top of the D-1 zone, and yesterday pipe was set on that horizon and yesterday it was gun perforated and those perforations

were tested and produced a flow of 3,000,000 cubic feet per day from those perforations, so that I believe we are going to be able to complete Bear Brandi No. 1 as a commercial gas well.

Trend Royalite Bolloque No. 1, you will notice there are three drill stem tests there, and this well is a few miles northeast of Imperial Clancy Sylvan Glen No. 1. That well was tested in the Lower Cretaceous, in the same zone, this is the Basal Quartz member, and it had some very interesting gas occurrences, but I felt we did not know enough about the well at the last Hearing to be able to calculate any reserve around that well, but this one is not very far away to the northeast, and I believe that a substantial reserve will develop in that area. The Jarvie well is southeast, still further southeast of Trend Royalite Bolloque, and it is southeast of Imperial Clancy Sylvan Glen, so that there are three gas wells in that area.

Imperial Waybrook No. 1 we included the Viking occurrences in our reserves of the Legal area in revised Table "A", but in addition to Viking there is this drill stem test in the Basal Quartz member of the Lower Cretaceous. The electric log of Imperial Waybrook No. 1 is included here. The reason I included it, although I did not calculate the reserves, is that the electric log shows (1) that the gas sand is in the Basal Quartz member of the Lower Cretaceous, and (2) that there is a considerable thickness of gas sand indicated by the electric log. There is at least 35 feet of gas sand indicated on the electric log. You will notice only one drill

stem test was taken, so that there may well be a gas reserve in the Basal Quartz sand at that area. In fact, the Baily Long Island well is a short distance from the well of the Imperial Waybrook, and there is a possibility that the two wells are in one gas pool in the Basal Quartz sand. I think that is all the comments I want to make on that.

Q I think that is all I have to submit this morning, Mr. Chairman. Dr. Nauss will be here during the balance of the week if there is any questioning to be done.

THE CHAIRMAN: I suggest if Counsel wish to cross-examine him, we can recall him later.

MR. McDONALD: Yes. I was going to call Mr. Poor the first thing in the morning, so that we can get him out of town. That is all for now, unless there are some questions that my friends might wish to ask. Dr. Nauss is available now.

THE CHAIRMAN: Yes.

MR. FENERTY: I think I will accomplish more in a shorter time if I have a chance of looking over some of these matters, and cross-examine Dr. Nauss later.

THE CHAIRMAN: Would somebody like to cross-examine Dr. Nauss now? Or would you prefer to wait until you have studied the transcript?

MR.NOLAN: We have no questions, Mr.Chairman.

THE CHAIRMAN: We will recall Dr. Nauss later.

MR. McDONALD: Yes.

THE CHAIRMAN: I believe you wish to make a statement this morning, Mr. Nolan?

MR.NOLAN: I wanted to speak about the appli-

cation of the Northwest Natural Gas Company which is now pending before the Board, in the sense that an application has been filed, but no evidence has yet been adduced. That application was adjourned until the 17th of April, and at that time the intention was that it should be adjourned until the 24th of April, at which time we would go on with such evidence as we could fit in during that week, after which an adjournment would be granted until the 29th of May, because the month of May was not a convenient month for the Board to hear any further evidence until the 29th, and that on the 29th we would proceed with the application, and complete it. It has become difficult to go on on the 24th of April, because of the unavoidable absence of one of our witnesses, who is required elsewhere, and he will not be available during that week, and so I propose, sir, with your permission, to formally appear here on the 17th of April, being the return date of my application, and request the Board to grant me an adjournment until the 29th day of May, at which time we will be ready to go on, and we fully expect that we will be able to complete our evidence in the two weeks beginning the 29th of May. Of course, if we are not able to complete it by reason of circumstances which we do not now anticipate, we understand that it might be necessary for the Board to adjourn the remainder of our hearing to a date in the future, to meet the convenience of the Board.

I wanted to say this today so that my learned friends and, of course, the Board, would know what our plans were, so that they themselves could make their own plans and that no one would be inconvenienced

by exprcting that we were going to go on on the 29th, because, as I say, on the 17th of April we will ask the Board to adjourn our application until Monday, the 29th of May.

MR.C. E. SMITH: Is there any reason why Mr. Nolan could not ask for his adjournment right now? There is nothing for the Board to do on Monday, but to sit here and adjourn, as I understand it.

MR.NOLAN: Well, as long as there is no doubt about the continuity of the proceedings being maintained. I do not want to ask the Board to come here on Monday, the 17th, simply for the privilege of listening to me say then what I have just said now.

MR. C. E. SMITH: That is what I have in mind.

THE CHAIRMAN: I was wondering about the members and the people who are not here today, if this would be sufficient notice? Now, the Board is going to be here on Monday anyway, but I would take your advice on that, Mr. Smith.

MR. C.E.SMITH : Well, we need not be concerned about an body who is not here. They are not here. There is one gentleman I expected to be here.

MR. J. C. MAHAFFY: It might be safer to adjourn on next Monday.

MR. C. E. SMITH: It might be safer, as Mr. Mahaffy suggests, if the Board is going to be here, to sit for a few minutes and adjourn on Monday. I do not think you would lose jurisdiction, or that Mr. Nolan need worry about it, but it might be better to leave it that way.

THE CHAIRMAN: When we adjourn the Hearing today

I would like to see Mr. McDonald, Mr. Bruce Smith and Mr. Nolan, if you will meet with us after we adjourn the Hearing today.

MR. McDONALD: Yes, sir.

MR.NOLAN: Yes, sir.

THE CHAIRMAN: Is there anybody else who would like to go on this morning? Mr. Frere, would you be ready to make any statement this morning? Have you got your witness here by any chance?

MR. FRERE: We are not prepared to make a statement this morning. We could tgo on with a statement later this week if that would meet the convenience of the Board.

MR. C. E. SMITH: We are not going to lose very much if we adjourn now, sir.

THE CHAIRMAN: In that case, we will adjourn until tomorrow morning at 9.30.

(The Hearing adjourned until 9.30 A.M. April 12th, 1950).